

(19)



Europäisches Patentamt

European Patent Office

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(11)

EP 1 154 354 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

14.11.2001 Bulletin 2001/46

(51) Int Cl.7: G06F 13/42

(21) Application number: 01101367.9

(22) Date of filing: 22.01.2001

(84) Designated Contracting States:

AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR

Designated Extension States:

AL LT LV MK RO SI

(30) Priority: 13.05.2000 KR 2000025618

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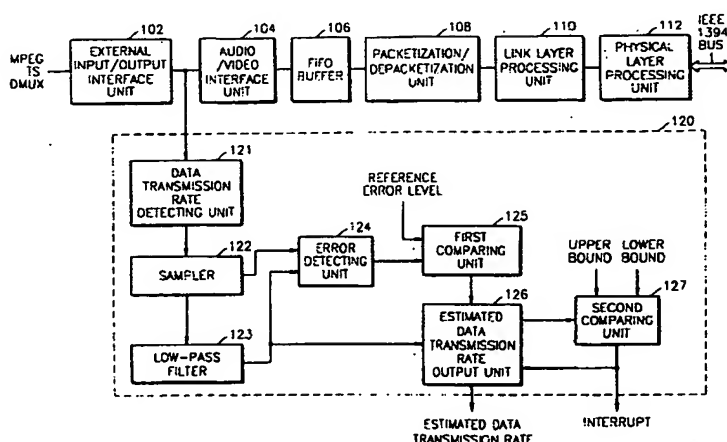
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(54) Apparatus for detecting data transmission rate and method thereof

(57) An apparatus for detecting a data transmission rate by recognizing an amount of real-time transmitted data and a changed amount of the data so as to allocate an appropriate bandwidth required to transmit/receive data in a system in which a serial bus such as an IEEE 1394 is implemented, is provided. The apparatus for detecting a data transmission rate through a serial bus includes a data transmission rate detecting unit for detecting a data transmission rate of bit stream data transmitted through a predetermined transmission line; a sampler for sampling a data transmission rate detected by the data transmission rate detecting unit at a predetermined period; a low-pass filter for low-pass filtering a value sampled by the sampler; an error detecting unit for detecting an error value in the data transmission rate

of the transmitted bit stream data using the value sampled by the sampler and the low-pass filtered value; a first comparing unit for comparing the error value detected by the error detecting unit with a reference error level; an estimated data transmission rate output unit for outputting an estimated data transmission rate on the basis of the low-pass filtered value when the error value is smaller than the reference error level; and a second comparing unit for outputting the estimated data transmission rate from the estimated data transmission rate output unit only in a case where the estimated data transmission rate does not exist between an upper bound and a lower bound when the present operation mode is a transmit/receive tracking mode. Accordingly, the bandwidth of the serial bus such as the IEEE 1394 can be efficiently operated.

FIG. 1



Description

[0001] The present invention relates to an apparatus for detecting a data transmission rate and a method thereof, and more particularly, to an apparatus for automatically detecting a data transmission rate and a method thereof in a system using a data transmission line such as an IEEE 1394 bus.

[0002] An IEEE 1394 bus as a new high-performance serial bus has characteristics such as a low price, a high speed, the use of a small number cable, and simple connection etc. In particular, the IEEE 1394 bus supports an isochronous protocol for real-time processing of digital data transmitted between devices. The data transmission rate of the IEEE 1394 bus is 100 ~ 400Mbps. Thus, the IEEE 1394 bus is important as one method of connecting to many peripheral devices and systems having a large amount of data processing such as a camcorder, scanner, camera, picture conference, and video on demand (VOD) system.

[0003] However, the devices connected to the IEEE 1394 bus are used by dividing the isochronous bandwidth allocated by maximum 100μs. Thus, there can be devices in which all of the allocated bandwidth is not used and to which the maximum bandwidth is allocated. In a case where there are many devices as above, the bandwidth of the IEEE 1394 bus is inefficiently operated. That is, although all of the bandwidth of the IEEE 1394 bus is not busy, a phenomenon that the bandwidth is not allocated to another device can occur. The phenomenon can limit the maximum number of devices which are capable of being connected to the IEEE 1394 bus.

[0004] Thus, in order to efficiently utilize the bandwidth of the IEEE 1394 bus, preferably, the optimum bandwidth is allocated to devices connected to the IEEE 1394 bus. For this purpose, exact bit rates for each device must be estimated in real time.

[0005] To solve the above problems, it is the object of the present invention to provide an apparatus for detecting a data transmission rate by recognizing an amount of real-time transmitted data so as to allocate an appropriate bandwidth required to transmit/receive data in a system in which a serial bus such as an IEEE 1394 is used.

[0006] Accordingly, to achieve the above object, there is provided an apparatus for detecting a data transmission rate through a serial bus. The apparatus includes a data transmission rate detecting unit for detecting a data transmission rate of bit stream data transmitted through a predetermined transmission line; a sampler for sampling a data transmission rate detected by the data transmission rate detecting unit at a predetermined period; a low-pass filter for low-pass filtering a value sampled by the sampler; an error detecting unit for detecting an error value in the data transmission rate of the transmitted bit stream data using the value sampled by the sampler and the low-pass filtered value; a comparing unit for comparing the error value detected by the

error detecting unit with a reference error level; and an estimated data transmission rate output unit for outputting an estimated data transmission rate on the basis of the low-pass filtered value when the error value is smaller than the reference error level.

[0007] According to an aspect of the present invention, there is provided an apparatus for detecting a data transmission rate and a method thereof which are capable of detecting a data transmission rate by recognizing the changed amount of real-time transmitted data.

[0008] According to a preferred embodiment of the present invention, there is provided an apparatus for detecting a data transmission rate through a serial bus after a bandwidth for the serial bus is allocated to a system. The apparatus includes a data transmission rate detecting unit for detecting a data transmission rate of bit stream data transmitted through a predetermined transmission line; a sampler for sampling a data transmission rate detected by the data transmission rate detecting unit at a predetermined period; a low-pass filter for low-pass filtering a value sampled by the sampler; an error detecting unit for detecting an error value in the data transmission rate of the transmitted bit stream data using the value sampled by the sampler and the low-pass filtered value; a first comparing unit for comparing the error value detected by the error detecting unit with a reference error level; an estimated data transmission rate output unit for outputting an estimated data transmission rate on the basis of the low-pass filtered value when the error value is smaller than the reference error level; and a second comparing unit for comparing the estimated data transmission rate with an upper bound and a lower bound so as to notify whether the estimated data transmission rate output from the estimated data transmission rate output unit exists between the upper bound and the lower bound set by a user according to the allocated bandwidth and to determine whether the estimated data transmission rate is output.

[0009] Furthermore, there is provided a method for detecting a data transmission rate transmitted through a serial bus. The method comprises the steps of: detecting a data transmission rate of bit stream data transmitted through a predetermined transmission line; detecting an error in the data transmission rate at a first predetermined period using the detected data transmission rate; comparing the error with a reference error level; checking the present operation mode when the error is smaller than the reference error level; outputting an estimated data transmission rate for the first predetermined period using the data transmission rate when the present operation mode is a transmit/receive average mode; and outputting the estimated data transmission rate for the first predetermined period in a case where the estimated data transmission rate for the first predetermined period does not exist between a predetermined upper bound and a predetermined lower bound when the present operation mode is a transmit/receive tracking mode.

[0010] The above object and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a block diagram of a system in which a preferred embodiment of an apparatus for detecting a data transmission rate according to the present invention is implemented;

FIGS. 2A and 2B are diagrams illustrating the results of input and output simulation of a low-pass filter shown in FIG. 1;

FIG. 3 is a block diagram of a system in which another preferred embodiment of an apparatus for detecting a data transmission rate according to the present invention is implemented; and

FIG. 4 is a flow chart illustrating a method for detecting a data transmission rate according to the present invention.

[0011] Referring to FIG. 1, a system employing an apparatus for detecting a data transmission rate according to the present invention includes an external input/output interface unit 102, an audio/video interface unit 104, a first-in first-out (FIFO) buffer 106, a packetization/depacketization unit 108, a link layer processing unit 110, a physical layer processing unit 112, and an apparatus for detecting a data transmission rate 120 according to the present invention.

[0012] The external input/output interface unit 102 interfaces with a MPEG transport stream (TS) demultiplexer and converts an external clock to a system clock. The audio/video interface unit 104 inserts a 10-byte distributed system-service (DSS) header and a time stamp into data when data are transmitted through an IEEE 1394 bus, and removes the 10-byte DSS header and processes delay of a packet or reads the data within a designated time by comparing the time stamp with a cycle timer when the data is received from the IEEE 1394 bus.

[0013] The FIFO buffer 106 receives and transmits the data and has the form of a dual port RAM. The packetization/depacketization unit 108 packetizes the data by inserting a packet header into the data transmitted through the IEEE 1394 bus and depacketizes the data received from the IEEE 1394 bus and converts a clock for interface with a link. The link layer processing unit 110 processes a link layer for transmitting/receiving packetized data. The physical layer processing unit 112 performs physical matching with the IEEE 1394 bus.

[0014] The apparatus for detecting a data transmission rate 120 shown in FIG. 1 includes a data transmission rate detecting unit 121, a sampler 122, a low-pass filter 123, an error detecting unit 124, a first comparing unit 125, an estimated data transmission rate output unit 126, and a second comparing unit 127. The apparatus for detecting a data transmission rate 120 is operated by being classified into a transmit/receive average mode

for allocating an initial bandwidth and a transmit/receive tracking mode for allocating the bandwidth required to measure the changed amount of the data transmitted at a real time in a state that the bandwidth is allocated.

[0015] First, during the transmit/receive average mode, the data transmission rate detecting unit 121 detects a data transmission rate of the transmitted bit stream data by counting up or down whenever bit stream data in a word unit is transmitted from the external input/output interface unit 102 to the audio/video interface unit 104. Likewise, a detected data transmission rate is cleared according to the sampled period of the sampler 122. Here, the data transmission rate detecting unit 121 may be set to detect the data transmission rate of the bit stream data in a word unit transmitted from the audio/video interface unit 104 to the external input/output interface unit 102. The operation condition is set by a user.

[0016] The sampler 122 samples a value detected by the data transmission rate detecting unit 121 by 125Hz. The sampled value is transmitted to the low-pass filter 123 and the error detecting unit 124, respectively.

[0017] The low-pass filter 123 formed of an infinite impulse response (IIR) filter low-pass filters the value sampled by the sampler 122. As can be seen from FIGS. 2A and 2B illustrating the results of input and output simulation of a low-pass filter, the low-pass filter 123 is designed to ignore instantaneous change. FIG. 2A is a waveform input to the low-pass filter 123, and FIG. 2B is a waveform output from the low-pass filter 123. The value filtered by the low-pass filter 123 are transmitted to the error detecting unit 124.

[0018] The error detecting unit 124 detects an error of one isochronous period for the data transmission rate of the transmitted bit stream data using the sampled value transmitted from the sampler 122 and the filtered value transmitted from the low-pass filter 123. For this purpose, the error detecting unit 124 calculates the sampled value of the one isochronous period by dividing the value sampled by the sampler 122 by 64. This is the reason why the sampled value is sampled at 125Hz, whereas the one isochronous period is 125 μ s. The filtered value of the one isochronous period are also calculated by dividing the filtered value transmitted from the low-pass filter 123 by 64. Next, an absolute difference between the filtered value of the one isochronous period and the sampled value of the one isochronous period is calculated. The error of the one isochronous period is detected by dividing a calculated absolute difference by the sampled value of the one isochronous period. The detected error of the one isochronous period is transmitted to the first comparing unit 125.

[0019] The first comparing unit 125 compares whether the error transmitted from the error detecting unit 124 is smaller than a preset reference error level. Here, the reference error level is set by a user and is set by selecting one of 7 steps considering the accuracy and the processing speed of the data transmission rate to be detected. That is, the user sets the reference error level by

selecting one of 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, and 1/128 of the input data transmission rate.

[0020] For example, in a case where the reference error level is set to '1/2', the accuracy of the estimated data transmission rate is lower than that in a case where the reference error level is differently set. However, in this case, the estimated data transmission rate can be obtained faster. On the other hand, in a case where the reference error level is set to '1/128', the accuracy of the estimated data transmission rate is higher than that in a case where the reference error level is differently set. However, in this case, it takes more time to obtain the estimated data transmission rate than when the error level is differently set. As a result of comparing by the first comparing unit 125, in a case where the detected error is smaller than the reference error level, the first comparing unit 125 outputs a comparison result signal so that the estimated data transmission rate may be output from the estimated data transmission rate output unit 126.

[0021] The estimated data transmission rate output unit 126 outputs the estimated data transmission rate according to the compared result provided from the first comparing unit 125. The estimated data transmission rate is filtered value of one isochronous period calculated by dividing the filtered value transmitted from the low-pass filter 123 by 64. Since the present operation mode is a transmit/receive average mode, the estimated data transmission rate output unit 126 outputs the estimated data transmission rate to the outside. As a result, an initial bandwidth is allocated to a corresponding device on the basis of the estimated data transmission rate. When the allocation of the bandwidth is performed by a bus manager (not shown) of the IEEE 1394 bus, the estimated data transmission rate is transmitted to the bus manager. Likewise, the estimated data transmission rate output to the outside is transmitted to a device related to the allocation of the bandwidth of the corresponding device. Here, before the estimated data transmission rate is transmitted to the device, the user can recognize the estimated data transmission rate.

[0022] However, in a case where the present operation mode is a tracking mode, the data transmission rate detecting unit 121, the sampler 122, the low-pass filter 123, the error detecting unit 124, and the first comparing unit 125 performs the same operations as those in case of the transmit/receive average mode. The estimated data transmission rate output unit 126 also perform the same estimation of the data transmission rate as that in case of the transmit/receive average mode. However, when the data transmission rate is estimated, the data transmission rate is output to the second comparing unit 127 before being output to the outside.

[0023] The second comparing unit 127 compares a preset upper bound and a preset lower bound with the estimated data transmission rate when the estimated data transmission rate is applied. This is to check whether the estimated data transmission rate does not exist

between the upper bound and the lower bound. The value of the upper bound and the lower bound is set by the user. The user determines the value of the upper bound and the lower bound on the basis of the data transmission rate measured during the average mode. The estimated data transmission rate satisfying the comparison condition in the first comparing unit 125 is used to ignore the estimated data transmission rate which does not exist between the upper bound and the lower bound before reaching a stable state (or an average state).

[0024] The second comparing unit 127 provides an output control signal to the estimated data transmission rate output unit 126 while generating an interrupt to the outside in a case where the estimated data transmission rate does not exist between the upper bound and the lower bound. The estimated data transmission rate output unit 126, controlled by the output control signal, outputs the estimated data transmission rate to the outside. However, in a case where the estimated data transmission rate exists between the upper bound and the lower bound, the change of a corresponding bandwidth is unnecessary. Thus, the second comparing unit 127 repeatedly compares the estimated data transmission rate provided from the estimated data transmission rate output unit 126 with the upper bound and the lower bound. Here, the estimated data transmission rate output unit 126 does not output the estimated data transmission rate to the outside. The output estimated data rate is provided to a device in which the bandwidth allocated to the corresponding device can be varied. When a bus manager (not shown) of the IEEE 1394 bus can vary the bandwidth allocated to the device, the estimated data transmission rate is transmitted to the bus manager. Here, before the estimated data transmission rate is transmitted to the device such as the bus manager, the user can recognize the estimated data transmission rate.

[0025] Referring to FIG. 3, all function blocks excluding an error detecting unit 301 and a first comparing unit 302 in another embodiment of an apparatus for detecting a data transmission rate 300 are the same as those shown in FIG. 1. Thus, to avoid redundancy, the operations of only the error detecting unit 301 and the first comparing unit 302 will be described.

[0026] As shown in FIG. 1, when a value sampled at 125Hz is output from the sampler 122, the sampled value is low-pass filtered and output from the low-pass filter 123, and the error detecting unit 301 detects the error of one isochronous period. For this purpose, the error detecting unit 301 calculates the sampled value of the one isochronous period by dividing the sampled value by 64 and calculates the low-pass filtered value of the one isochronous period by dividing the low-pass filtered value by 64. An absolute difference between the calculated low-pass filtered value and the sampled value is detected as an error value of the one isochronous period. The detected error value is transmitted to the first comparing unit 302.

[0027] The first comparing unit 302, like in the first comparing unit 125 of FIG. 1, sets a value in which one of 7 error levels set by the user is multiplied by the sampled value of the one isochronous period calculated by dividing the sampled value provided from the sampler 122 by 64, as the reference error level. The reference error level is compared with the error transmitted from the error detecting unit 301. As a result of comparison, when the error provided from the error detecting unit 301 is smaller than the set reference error level, the output control signal is output to the estimated data transmission rate output unit 126. As a result, the estimated data transmission rate output unit 126 outputs the data transmission rate estimated according to the operation mode set as in FIG. 1 to the outside or the second comparing unit 127.

[0028] Referring to FIG. 4, the data transmission rate transmitted through a predetermined transmission line is detected (step 401). A method for detecting the data transmission rate is the same as that described with reference to the data transmission rate detecting unit 121 of FIG. 1. The transmission line exists between the external input/output interface unit 102 and the audio/video interface unit 104 of FIG. 1 and is a line for transmitting data to or from the IEEE 1394 bus.

[0029] The data transmission rate detected in step 401 is sampled at a predetermined period (step 403). The predetermined frequency is 125Hz, as described for the sampler 122 of FIG. 1. The sampled data transmission rate is low-pass filtered (step 405).

[0030] The error of one isochronous period is detected using the value sampled in step 403 and the value low-pass filtered in step 405 (step 407). A method for detecting the error is the same as that described with reference to the error detecting unit 124 of FIG. 1. When the error is detected, it is checked whether the detected error is smaller than the reference error level (step 409). The reference error level is set by the user as described in FIG. 1, or using a resultant value in which the error level set by the user and the sampled value is operated on, as described in FIG. 3.

[0031] As a result of checking in step 409, when the detected error is not smaller than the reference error level, the operation returns to step 401, and then, the above steps are repeated. However, as a result of checking in step 409, when the detected error is smaller than the reference error level, the present mode is checked (step 411).

[0032] As a result of checking in step 411, when the present mode is a transmit/receive average mode, the estimated data transmission rate is output to a device (not shown) for setting the bandwidth of a corresponding device (step 413). The estimation of the data transmission rate is performed as described with reference to the estimated data transmission rate output unit 126 of FIG. 1.

[0033] Meanwhile, when the present mode is a transmit/receive tracking mode, it is checked whether the es-

timated data transmission rate exists between the lower bound and the upper bound (step 415). The lower bound and the upper bound are set by the same condition as described with reference to FIG. 1.

[0034] As a result of checking in step 415, when the estimated data transmission rate exists between the lower bound and the upper bound, the operation returns to step 401, and then, the above steps are repeated. However, when as a result of checking in step 415, the estimated data transmission rate does not exist between the lower bound and the upper bound, an interrupt is generated (step 417). The interrupt requires the change of the allocated bandwidth. Thus, the interrupt is supplied to a bus manager (not shown) for the IEEE 1394 bus or to a device for changing the bandwidth of the corresponding device. The estimated data transmission rate is output so as to be supplied to the device (step 419). The estimation of the data transmission rate is performed as in step 413.

[0035] As described above, the present invention is used to allocate the appropriate bandwidth to a corresponding device by exactly detecting the data transmission rate of one isochronous period according to the transmit/receive average mode and the transmit/receive tracking mode in real time, and then can operate the bandwidth of the IEEE 1394 bus efficiently and more devices can be connected to the IEEE 1394 bus than in the prior art.

Claims

1. An apparatus for detecting a data transmission rate transmitted through a serial bus, the apparatus comprising:

a data transmission rate detecting unit for detecting a data transmission rate of bit stream data transmitted through a predetermined transmission line;

a sampler for sampling a data transmission rate detected by the data transmission rate detecting unit at a predetermined period;

a low-pass filter for low-pass filtering a value sampled by the sampler;

an error detecting unit for detecting an error value in the data transmission rate of the transmitted bit stream data using the value sampled by the sampler and the low-pass filtered value;

a first comparing unit for comparing the error value detected by the error detecting unit with a reference error level; and

an estimated data transmission rate output unit

for outputting an estimated data transmission rate on the basis of the low-pass filtered value when the error value is smaller than the reference error level.

2. The apparatus according to claim 1, wherein the error detecting unit is formed to detect the error value of one isochronous period, and the first comparing unit is formed to compare the error value of the one isochronous period with the reference error level, and the estimated data transmission rate output unit is formed to output the estimated data transmission rate of the one isochronous period, in a case where the serial bus is an IEEE 1394 bus.
3. The apparatus according to claim 2, wherein the error detecting unit is formed to calculate the low-pass filtered value of the one isochronous period from the low-pass filtered value, to calculate the sampled value of the one isochronous period from the sampled value, to divide an absolute difference between the low-pass filtered value of the one isochronous period and the sample value of the one isochronous period by the low-pass filtered value of the one isochronous period, and to detect the error of the one isochronous period.
4. The apparatus according to claim 2, wherein the first comparing unit sets one error level selected from a plurality of error levels by a user as the reference error level.
5. The apparatus according to claim 2, wherein the error detecting unit is formed to calculate the low-pass filtered value of the one isochronous period from the low-pass filtered value, to calculate the sampled value of the one isochronous period from the sampled value, to divide an absolute difference between the low-pass filtered value of the one isochronous period and the sample value of the one isochronous period by the low-pass filtered value of the one isochronous period and to detect the error value of the one isochronous period, and the first comparing unit sets a value obtained when one error level selected by a user from a plurality of error levels is multiplied by the sampled value of the one isochronous period, as the reference error level, and is formed to compare the error value of the one isochronous period with the reference error level.
6. The apparatus according to claim 2, wherein the estimated data transmission rate output unit calculates the low-pass filtered value of the one isochronous period from the low-pass filtered value and outputs the low-pass filtered value of the one isochronous period as the estimated data transmission rate.

7. The apparatus according to one of the claims 1 to 6, wherein the low-pass filter is an infinite impulse response (IIR) low-pass filter.

8. The apparatus according to one of the claims 1 to 7, wherein the predetermined transmission line is a line between an external input/output interface unit for interfacing with a MPEG transport stream (TS) demultiplexer and an audio/video interface unit.

9. The apparatus according to one of the claims 1 to 8, wherein the data transmission rate is detected by unit of word, and the predetermined frequency is set to 125Hz.

10. The apparatus according to one of the claims 1 to 9, wherein the data transmission rate through a serial bus is detected after a bandwidth for the serial bus is allocated to a system, the apparatus further comprising:
a second comparing unit for comparing the estimated data transmission rate with an upper bound and a lower bound so as to notify whether the estimated data transmission rate output from the estimated data transmission rate output unit exists between the upper bound and the lower bound set by a user according to the allocated bandwidth and to determine whether the estimated data transmission rate is output.

11. The apparatus according to claim 10, wherein the second comparing unit generates an interrupt for the notification and an output control signal into the estimated data transmission rate output unit so as to output the estimated data transmission rate, in a case where the estimated data transmission rate does not exist between the upper bound and the lower bound.

12. A method for detecting a data transmission rate through a serial bus, the method comprising the steps of:

a) detecting a data transmission rate of bit stream data transmitted through a predetermined transmission line;

b) detecting an error in the data transmission rate at a first predetermined period using the detected data transmission rate;

c) comparing the error with a reference error level;

d) checking the present operation mode when the error is smaller than the reference error level;

e) outputting an estimated data transmission rate for the first predetermined period using the data transmission rate when the present operation mode is a transmit/receive average mode; and

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f) outputting the estimated data transmission rate for the first predetermined period in a case where the estimated data transmission rate for the first predetermined period does not exist between a predetermined upper bound and a predetermined lower bound when the present operation mode is a transmit/receive tracking mode.

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13. The method according to claim 12, wherein the step b) comprises the steps of:

b1) sampling the detected data transmission rate at a second predetermined period;

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b2) low-pass filtering the sampled value in the step b1); and

b3) detecting the error in the data transmission rate of the bit stream data using the sampled value and the low-pass filtered value in the step b2).

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14. The method according to claim 12 or 13, wherein the reference error level in the step c) is one error level selected from a plurality of error levels by a user, or a value resulting from performing a predetermined operation on the one error level and the sampled value.

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15. The method according to claim 13, wherein the step a) is performed by unit of word, and the first predetermined period is one isochronous period, and the second predetermined frequency is 125Hz, in a case where the serial bus is an IEEE 1394 bus.

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16. The method according to claim 13, wherein the low-pass filtered value of the first predetermined period detected using the low-pass filtered value in the step b2) is output as the estimated data transmission rate in the steps e) and f).

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17. The method according to one of claims 12 to 16, wherein the predetermined upper bound and the predetermined lower bound in the step f) are determined on the basis of the estimated data transmission rate output in the step e), and the step f) comprises the step of notifying whether the estimated data transmission rate exists between the predetermined upper bound and the predetermined lower bound.

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FIG. 1

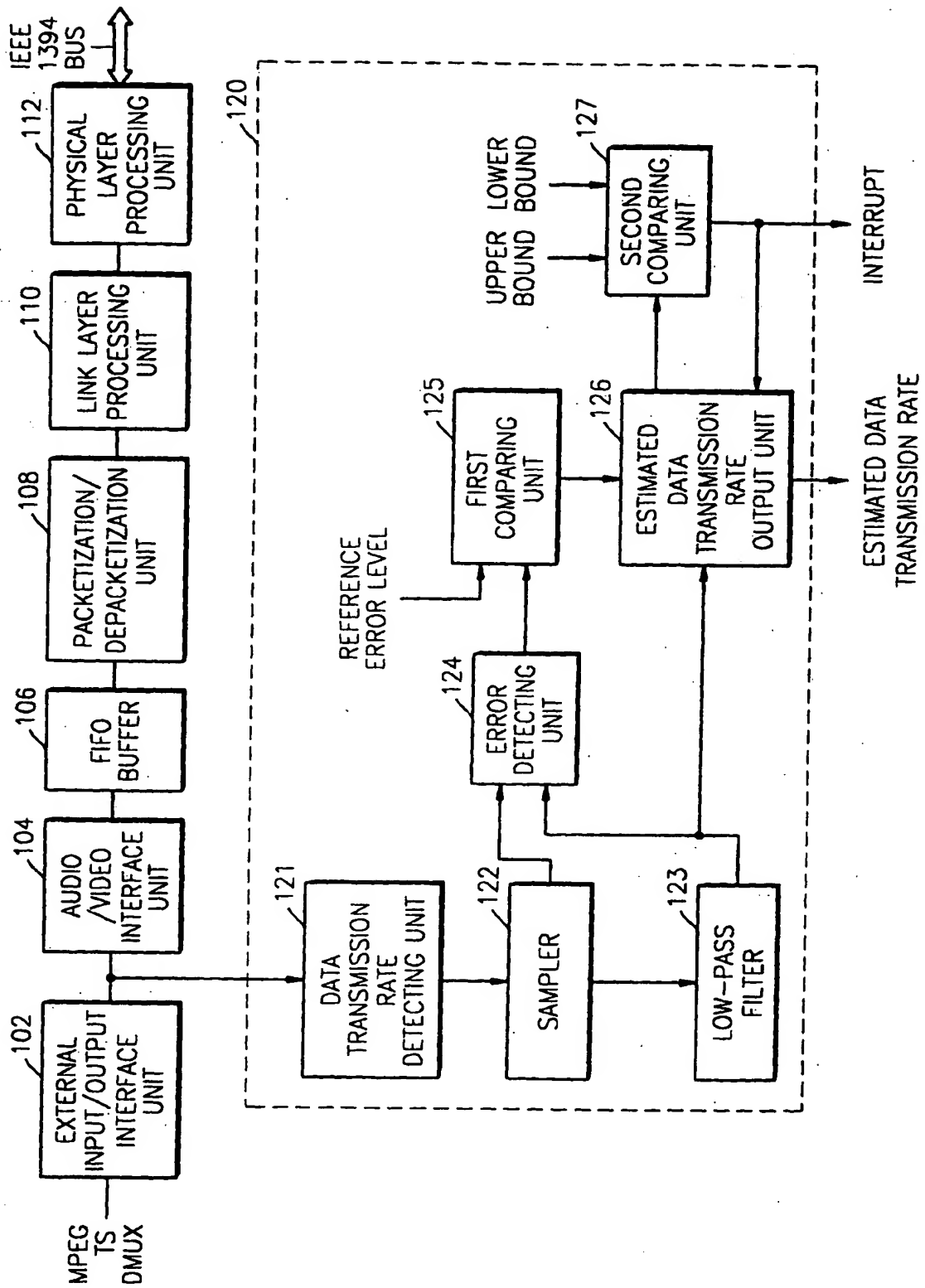


FIG. 2A

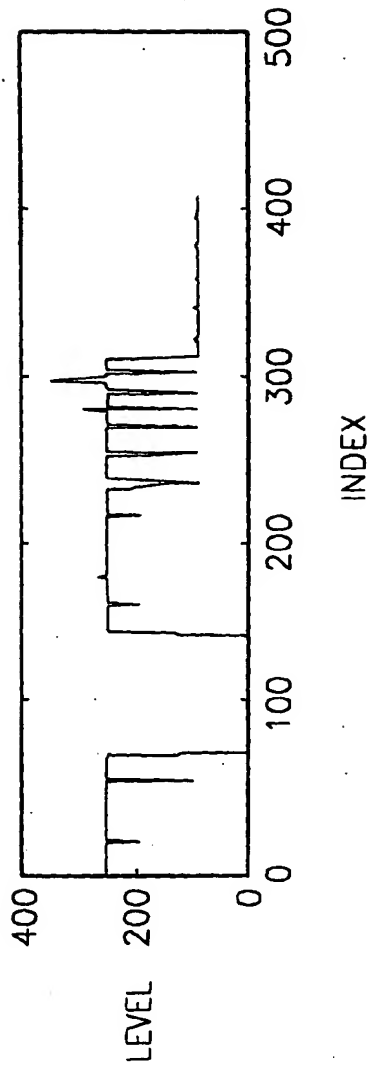


FIG. 2B

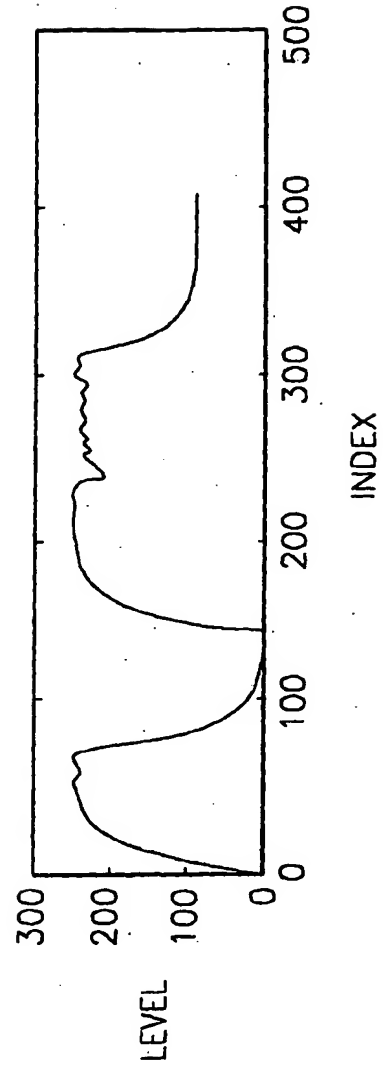


FIG. 3

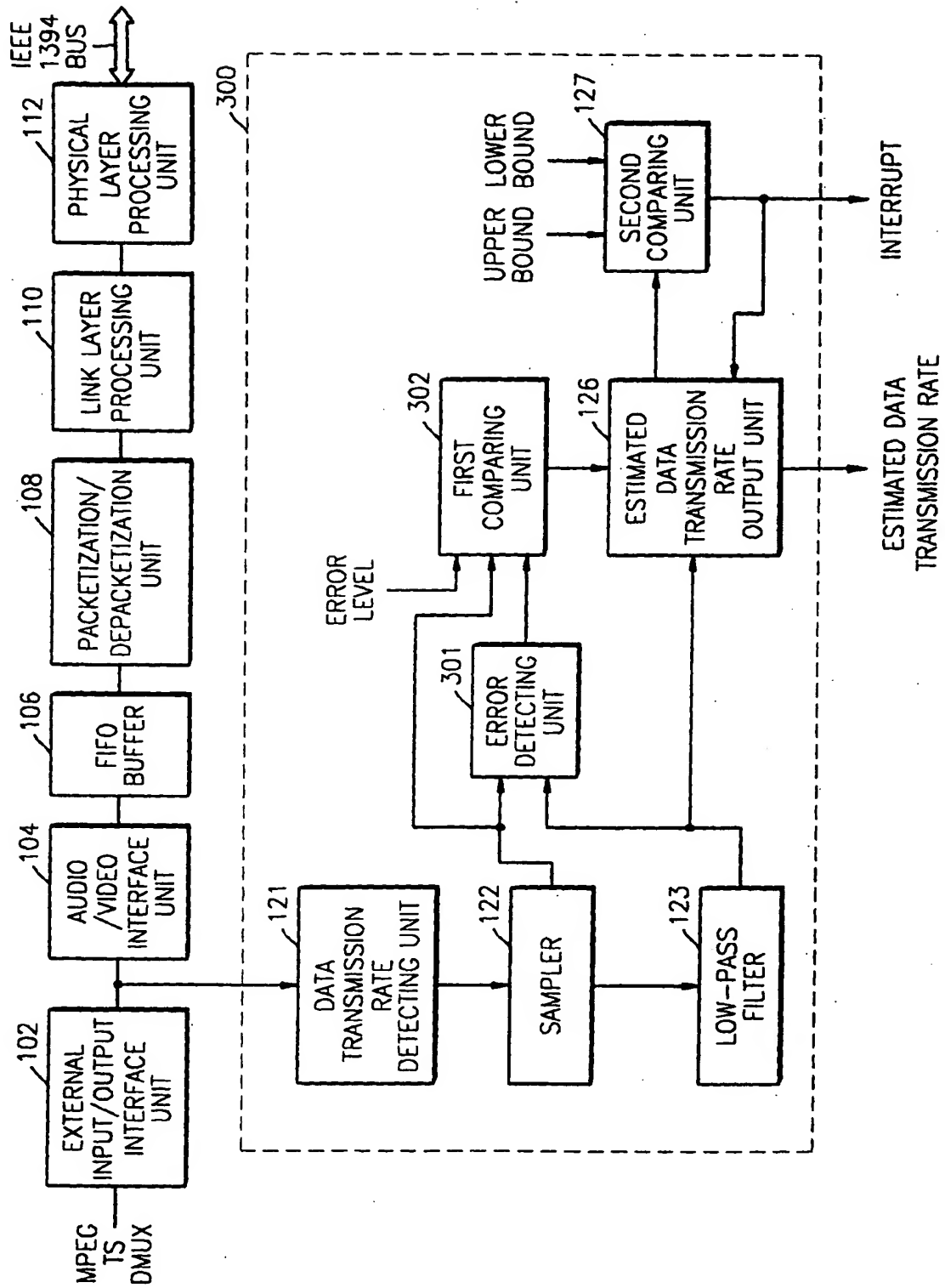
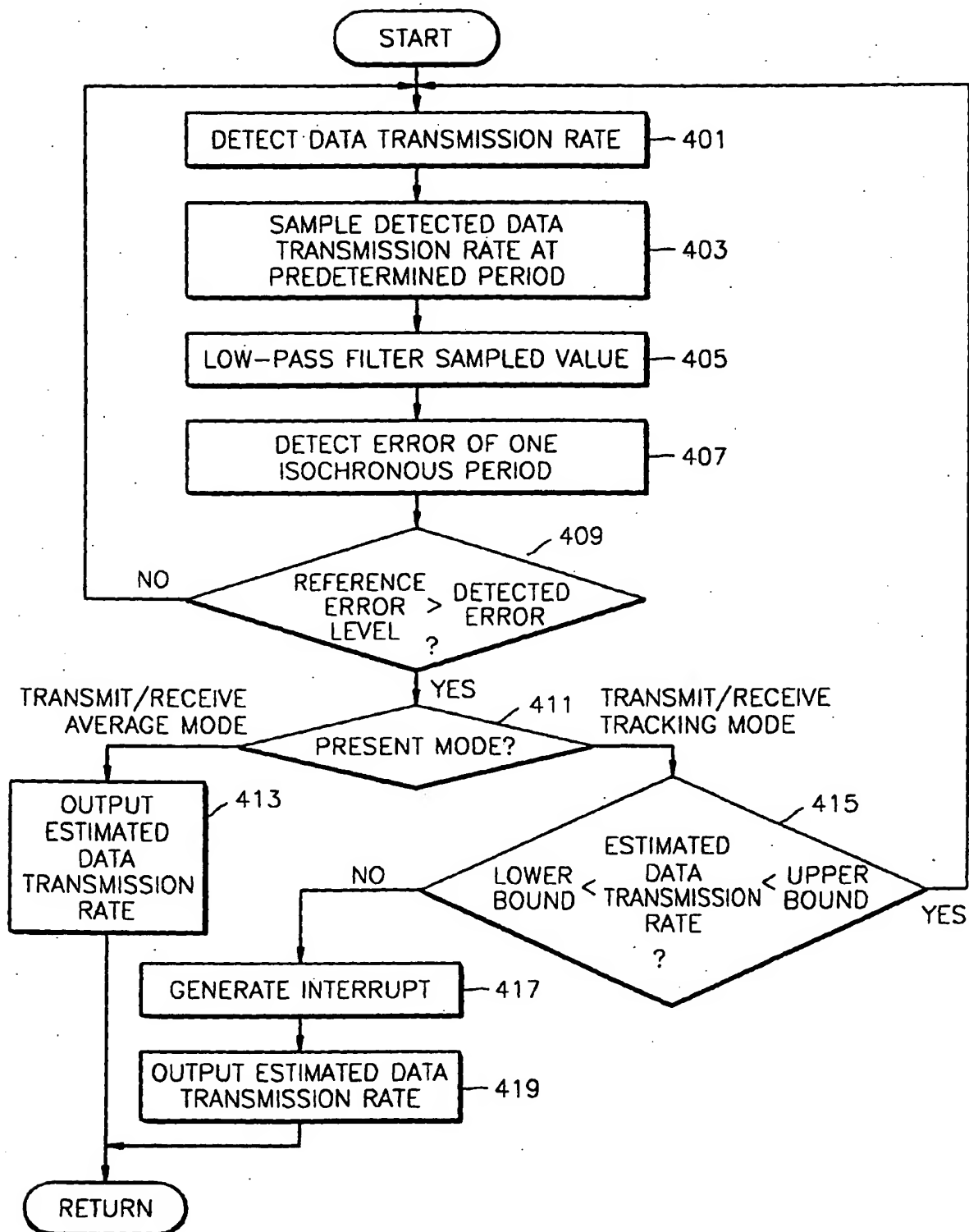
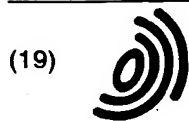


FIG. 4





(12)

EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
17.08.2005 Bulletin 2005/33

(51) Int Cl.7: G06F 13/42

(43) Date of publication A2:
14.11.2001 Bulletin 2001/46

(21) Application number: 01101367.9

(22) Date of filing: 22.01.2001

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

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(30) Priority: 13.05.2000 KR 2000025618

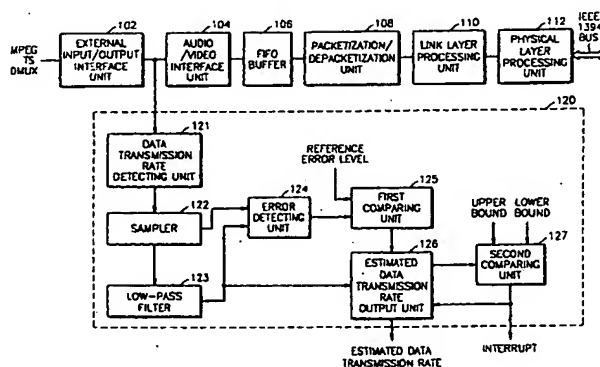
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(54) Apparatus for detecting data transmission rate and method thereof

(57) An apparatus for detecting a data transmission rate by recognizing an amount of real-time transmitted data and a changed amount of the data so as to allocate an appropriate bandwidth required to transmit/receive data in a system in which a serial bus such as an IEEE 1394 is implemented, is provided. The apparatus for detecting a data transmission rate through a serial bus includes a data transmission rate detecting unit for detecting a data transmission rate of bit stream data transmitted through a predetermined transmission line; a sampler for sampling a data transmission rate detected by the data transmission rate detecting unit at a predetermined period; a low-pass filter for low-pass filtering a value sampled by the sampler; an error detecting unit for detecting an error value in the data transmission rate

of the transmitted bit stream data using the value sampled by the sampler and the low-pass filtered value; a first comparing unit for comparing the error value detected by the error detecting unit with a reference error level; an estimated data transmission rate output unit for outputting an estimated data transmission rate on the basis of the low-pass filtered value when the error value is smaller than the reference error level; and a second comparing unit for outputting the estimated data transmission rate from the estimated data transmission rate output unit only in a case where the estimated data transmission rate does not exist between an upper bound and a lower bound when the present operation mode is a transmit/receive tracking mode. Accordingly, the bandwidth of the serial bus such as the IEEE 1394 can be efficiently operated.

FIG. 1





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 10 1367

| DOCUMENTS CONSIDERED TO BE RELEVANT | | | |
|--|---|--|--|
| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
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